

A new species of *Enteromius* from the Bale Mountain Region, southeastern Ethiopia (Teleostei: Cyprinidae)

Artem M. Prokofiev*, Boris A. Levin**,*** and Alexander S. Golubtsov*

A new species, *Enteromius baleensis*, is described from the Weyb River basin, Juba River system, Bale Mountain Region in southeastern Ethiopia. It differs from all other *Enteromius* in having the last unbranched dorsal-fin ray soft and flexible, scales moderately small (34–37 in lateral series), and incomplete lateral line. Molecular data (cytochrome b) reveal its inclusion as a new species in the *E. pleurogramma* species complex, widely distributed in Ethiopia. Furthermore, six other distinct lineages deserving the species status are also defined by molecular analysis inferred from cytochrome b sequences. From these lineages, only three have been named: *E. akakianus* (Central Rift Valley), *E. pleurogramma* (Lake Tana) and *E. yardiensis* (Afar Depression). Based on molecular data, *Enteromius baleensis* is sister to *E. akakianus*. Based on morphological features, *E. baleensis* is remarkably different from the other representatives of the *E. pleurogramma* complex by combining soft and flexible last unbranched dorsal-fin ray and incomplete lateral line, and by a number of the skeletal reductions. The new species is the only member of the *E. pleurogramma* complex inhabiting the Indian Ocean catchment in Ethiopia. It should be considered for protection as a narrow-range endemic species based on its current restricted distribution in the Weyb River basin.

Introduction

Small-sized African smiliogastrin minnows of the genus *Enteromius* are a mega-diverse assemblage of freshwater fish species widely distributed throughout the Afrotropical region, currently containing around 250 species thought to be valid (Fricke et al., 2021), and many others still awaiting description. Several generic names have been proposed by different authors (review in Lévéque & Daget, 1984) but until recent years the majority of the African minnows have been treated under

the collective name “*Barbus* sensu lato”. The genus *Barbus* in its strict sense is restricted to the large small-scaled tetraploid Euro-Mediterranean and West Asian species (Berrebi et al., 1996). Recent molecular studies (Yang et al., 2015; Ren & Mayden, 2016) supported a formerly proposed hypothesis about the close relationships between small Asian (*Puntius* and allies) and African minnows (Golubtsov & Krysanov, 1993), which were united in the tribe Smiliogastrini (Yang et al., 2015). Yang et al. (2015) proposed a resurrection of the genus *Enteromius* being the oldest available

* Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Leninskii pr. 33, Moscow 119071, Russia. E-mail: prokartster@gmail.com (corresponding author), sgolubtsov@gmail.com

** Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences, Yaroslavl Region, Borok 152742, Russia. E-mail: borislyovin@mail.ru

*** Cherepovets State University, Cherepovets 162600, Russia.

Literature cited

- Aljanabi, S. M. & I. Martinez. 1997. Universal and rapid salt-extraction of high quality genomic DNA for PCR-based techniques. *Nucleic Acids Research*, 25: 4692–4693.
- Armbruster, J. W., C. C. Stout & M. M. Hayes. 2016. An empirical test for convergence using African barbs (Cypriniformes: Cyprinidae). *Evolutionary Ecology*, 30: 435–450.
- Berrebi, P., M. Kottelat, P. Skelton & P. Ráb. 1996. Systematics of *Barbus*: state of the art and heuristic comments. *Folia Zoologica*, 45 (Supplement 1): 5–12.
- Beshera, K. A., P. M. Harris & R. L. Mayden. 2016. Novel evolutionary lineages in *Labeobarbus* (Cypriniformes; Cyprinidae) based on phylogenetic analyses of mtDNA sequences. *Zootaxa*, 4093: 363–381.
- Conway, K. W. & T. Moritz. 2006. *Barboides britzzi*, a new species of miniature cyprinid from Benin (Ostariophysi: Cyprinidae), with a neotype designation for *B. gracilis*. *Ichthyological Exploration of Freshwaters*, 17: 73–84.
- Conway, K. W. & M. L. J. Stiassny. 2008. Phylogenetic diagnosis of the African cyprinid genus *Clypeobarbus* (Ostariophysi: Cyprinidae), with the rehabilitation of *Clypeobarbus bomokandi*. *Ichthyological Research*, 55: 260–266.
- Darriba, D., G. L. Taboada, R. Doallo & D. Posada. 2012. jModelTest 2: more models, new heuristics and parallel computing. *Nature Methods*, 9: 772.
- De Graaf, M., H.-J. Megens, J. Samallo & F. A. Sibbing. 2007. Evolutionary origin of Lake Tana's (Ethiopia) small *Barbus* species: indications of rapid ecological divergence and speciation. *Animal Biology*, 57: 39–48.
- Elmi Mohamed, A. 2013. Managing shared river basins in the Horn of Africa: Ethiopian planned water projects on the Juba and Shabelle rivers and effects on downstream uses in Somalia. Pp. 139–151 in: Brebbia, C. A. (ed.), *River Basin Management VII*, WIT Press, Ashurst Lodge.
- Englmaier, G. K., Genanaw Tesfaye & N. G. Bogutskaya. 2020. A new species of *Enteromius* (Actinopterygii, Cyprinidae, Smiliogastrinae) from the Awash River, Ethiopia, and the re-establishment of *E. akakianus*. *ZooKeys*, 902: 107–150.
- Fricke, R., W. N. Eschmeyer & R. van der Laan. 2021. Catalog of fishes: genera, species, references. Available from <http://researcharchive.calacademy.org/>

- research/ichthyology/catalog/fishcatmain.asp. (accessed 1 February 2021).
- Golubtsov, A. S. & P. B. Berendzen. 2005. A review of the small barbs (*Barbus*, Cyprinidae) with a serrated dorsal spine from Ethiopia, with a discussion of the origin of forms with a reduced dorsal spine from the White Nile and Omo River tributaries. *Journal of Ichthyology*, 45 (Supplement 1): S58–S88.
- Golubtsov, A. S., Y. Y. Dgebuadze & M. V. Mina. 2002. Fishes of the Ethiopian Rift Valley. Pp. 167–258 in: C. Tudorancea, W. D. Taylor, G. Baele & M. A. Suchard, (eds.), *Ethiopian Rift Valley Lakes. Biology of Inland Waters Series*. Backhuys, Leiden.
- Golubtsov, A. S., N. B. Korostelev & B. A. Levin. 2021. Monsters with a shortened vertebral column: A population phenomenon in radiating fish *Labeobarbus* (Cyprinidae). *PLoS ONE* 16: e0239639.
- Golubtsov, A. S. & E. Y. Krysanov. 1993. Karyological study of some cyprinid species from Ethiopia: the ploidy differences between large and small *Barbus* of Africa. *Journal of Fish Biology*, 42: 445–455.
- Golubtsov, A. S. & E. Y. Krysanov. 2003. Karyological comparison of the small African barbs *Barbus paludinosus* (Cyprinidae) with developed and reduced spine in the dorsal fin. *Journal of Ichthyology*, 43: 245–252.
- Golubtsov, A. S., P. H. Skelton, K. M. Shidlovsky, E. R. Swartz & E. Y. Krysanov. 2004. The discovery of a *Pseudobarbus*-like barb in the Bale mountain region, Ethiopia: an ancient trace of endemic South-African cyprinids in the Horn of Africa? Pp. 108–109 in: XI European Congress of Ichthyology, September 6–10, 2004, Tallinn.
- Gouy, M., S. Guindon & O. Gascuel. 2009. SeaView version 4: a multiplatform graphical user interface for sequence alignment and phylogenetic tree building. *Molecular Biology and Evolution*, 27: 221–224.
- Greenwood, P. H. 1962. A revision of certain *Barbus* species (Pisces, Cyprinidae) from east, central, and south Africa. *Bulletin of the British Museum (Natural History). Zoology*, 8: 151–208.
- Guindon, S., J.-F. Dufayard, V. Lefort, M. Anisimova, W. Hordijk & O. Gascuel. 2010. New algorithms and methods to estimate maximum-likelihood phylogenies: assessing the performance of PhyML 3.0. *Systematic Biology*, 59: 307–321.
- Hayes, M. M. & J. W. Armbruster. 2017. The taxonomy and relationships of the African small barbs (Cypriniformes: Cyprinidae). *Copeia*, 105: 348–362.
- Helaers, R. & M. C. Milinkovitch. 2010. MetaPIGA v2.0: maximum likelihood large phylogeny estimation using the metapopulation genetic algorithm and other stochastic heuristics. *BMC Bioinformatics*, 11: 379.
- Jakubowski, M. 1970. [Methods of revealing and colouring of canal system in lateral line and bone elements in fish]. *Zoologichesky Zhurnal*, 49: 1398–1401 [in Russian].
- Kumar, S., G. Stecher & K. Tamura. 2016. MEGA7: molecular evolutionary genetics analysis version 7.0 for bigger datasets. *Molecular Biology and Evolution*, 33: 1870–1874.
- Lanfear, R., B. Calcott, S. Y. W. Ho & S. Guindon. 2012. PartitionFinder: combined selection of partitioning schemes and substitution models for phylogenetic analyses. *Molecular Biology and Evolution*, 29: 1695–1701.
- Levéque, C. & J. Daget 1984. Cyprinidae. Pp. 217–342 in: J. Daget, J. P. Gosse & D. F. E. Thys van den Audenaerde (eds.), *Check-list of the freshwater fishes of Africa. Volume 1*. ISBN, Bruxelles; MRAC, Tervuren & ORSTOM, Paris.
- Levin, B. A., J. Freyhof, Z. Lajbner, S. Pereira, A. Abdoli, M. Gaffaroglu, M. Özuluğ, H. R. Rubenyan, V. B. Salnikov & I. Doadrio. 2012. Phylogenetic relationships of the algae scraping cyprinid genus *Capoeta* (Teleostei: Cyprinidae). *Molecular Phylogenetics and Evolution*, 62: 542–549.
- Machordom, A. & I. Doadrio. 2001. Evolutionary history and speciation modes in the cyprinid genus *Barbus*. *Proceedings of the Royal Society of London B: Biological Sciences*, 268: 1297–1306.
- Minh, B. Q., M. A. T. Nguyen & A. von Haeseler. 2013. Ultrafast approximation for phylogenetic bootstrap. *Molecular Biology and Evolution*, 30: 1188–1195.
- Palumbi, S. R. 1996. Nucleic acids II: the polymerase chain reaction. Pp. 205–247 in: D. M. Hillis, C. Moritz & B. K. Mable (eds.), *Molecular Systematics*. Second edition. Sinauer, Sunderland.
- Paugy, G. 2010. *The Ethiopian subregion fish fauna: an original patchwork with various origins*. *Hydrobiologia*, 649: 301–315.
- Perdices, A., E. Bermingham, A. Montilla & I. Doadrio. 2002. Evolutionary history of the genus *Rhamdia* (Teleostei: Pimelodidae) in Central America. *Molecular Phylogenetics and Evolution*, 25: 172–189.
- Pethiyagoda, R., M. Meegaskumbura & K. Maduwage. 2012. A synopsis of the South Asian fishes referred to *Puntius* (Pisces: Cyprinidae). *Ichthyological Explorations of Freshwaters*, 23: 69–95.
- Rambaut, A. 2017. FigTree-version 1.4. 3, a graphical viewer of phylogenetic trees. Available from <http://tree.bio.ed.ac.uk/software/>
- Rambaut, A., M. A. Suchard, D. Xie & A. J. Drummond. 2014. Tracer 1.6. Available from <http://beast.bio.ed.ac.uk/Tracer>
- Redeat Habteselassie. 2012. Fishes of Ethiopia: annotated checklist with pictorial identification guide. *Ethiopian Fisheries and Aquatic Science Association, Addis-Ababa*, 250 pp.
- Ren, Q. & R. L. Mayden. 2016. Molecular phylogeny and biogeography of African diploid barbs, “*Barbus*”, and allies in Africa and Asia (Teleostei: Cypriniformes). *Zoologica Scripta*, 45: 642–649.
- Ronquist, F. & J. P. Huelsenbeck. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics*, 19: 1572–1574.

- Saitoh, K., T. Sado, R. L. Mayden, N. Hanzawa, K. Nakamura, M. Nishida & M. Miya. 2006. Mitogenomic evolution and interrelationships of the Cypriniformes (Actinopterygii: Ostariophysi): the first evidence toward resolution of higher-level relationships of the world's largest freshwater fish clade based on 59 whole mitogenome sequences. *Journal of Molecular Evolution*, 63: 826–841.
- Schmidt, R. C., H. L. Bart Jr. & W. D. Nyberg. 2017. Multi-locus phylogeny reveals instances of mitochondrial introgression and unrecognized diversity in Kenyan barbs (Cyprininae: Smiliogastrini). *Molecular Phylogenetics and Evolution*, 111: 35–43.
- Shibru Tedla & Fisseha Haile Meskel. 1981. Introduction and transplantation of freshwater fish species in Ethiopia. *SINET: Ethiopian Journal of Science*, 4: 69–72.
- Skelton, P. H. 1980. Systematics and biogeography of the redfin *Barbus* species (Pisces: Cyprinidae) from southern Africa. PhD dissertation, Rhodes University, Grahamstown, ix + 416 pp.
- Skelton, P. H. 1988. A taxonomic revision of the redfin minnows (Pisces, Cyprinidae) from southern Africa. *Annals of the Cape Provincial Museum (Natural History)*, 16: 201–307.
- Skelton, P. H., E. R. Swartz & E. J. Vreven. 2018. The identity of *Barbus capensis* Smith, 1841 and the generic status of southern African tetraploid cyprinids (Teleostei, Cyprinidae). *European Journal of Taxonomy*, 410: 1–29.
- Stiassny, M. L. J. & H. Sakharova. 2016. Review of the smiliogastrin cyprinids of the Kwilu River (Kasai Basin, central Africa), revised diagnosis for *Clypeobarbus* (Cyprinidae: Cyprininae: Smiliogastrini) and description of a new species. *Journal of Fish Biology*, 88: 1394–1412.
- Taki, Y., A. Katsuyama & T. Urushido. 1978. Comparative morphology and interspecific relationships of the cyprinid genus *Puntius*. *Japanese Journal of Ichthyology*, 25: 1–8.
- Tsigenopoulos, C. S. & P. Berrebi. 2000. Molecular phylogeny of North Mediterranean freshwater barbs (genus *Barbus*: Cyprinidae) inferred from cytochrome b sequences: biogeographic and systematic implications. *Molecular Phylogenetics and Evolution*, 14: 165–179.
- Tsigenopoulos, C. S., P. Ráb, D. Naran & P. Berrebi. 2002. Multiple origins of polyploidy in the phylogeny of southern African barbs (Cyprinidae) as inferred from mtDNA markers. *Heredity*, 88: 466–473.
- Vinciguerra, D. 1893. Di alcuni pesci raccolti nel paese dei Somali dall'Ing.re L. Brichetti-Robecchi. *Annali di Museo Civico di Storia Naturale "Giacomo Doria"*, serie 2a, 33: 448–455.
- Vinciguerra, D. 1897. Pesci raccolti dal Cap. V. Bottego durante la sua seconda spedizione nelle regioni dei Somalia e dei Galla. *Annali di Museo Civico di Storia Naturale "Giacomo Doria"*, serie 2a, 37: 343–364.
- Vinciguerra, D. 1922. Contribuzione alla conoscenza della fauna ittiologica dello Uebi Scebeli. *Annali di Museo Civico di Storia Naturale "Giacomo Doria"*, 49: 378–389, plate V.
- Yang, L., T. Sado, M. V. Hirt, E. Pasco-Viel, M. Arunachalam, J. Li, X. Wang, J. Freyhof, K. Saitoh, A. M. Simons, M. Miya, S. He & R. L. Mayden. 2015. Phylogeny and polyploidy: resolving the classification of cyprinine fishes (Teleostei: Cypriniformes). *Molecular Phylogenetics and Evolution*, 85: 97–116.

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